



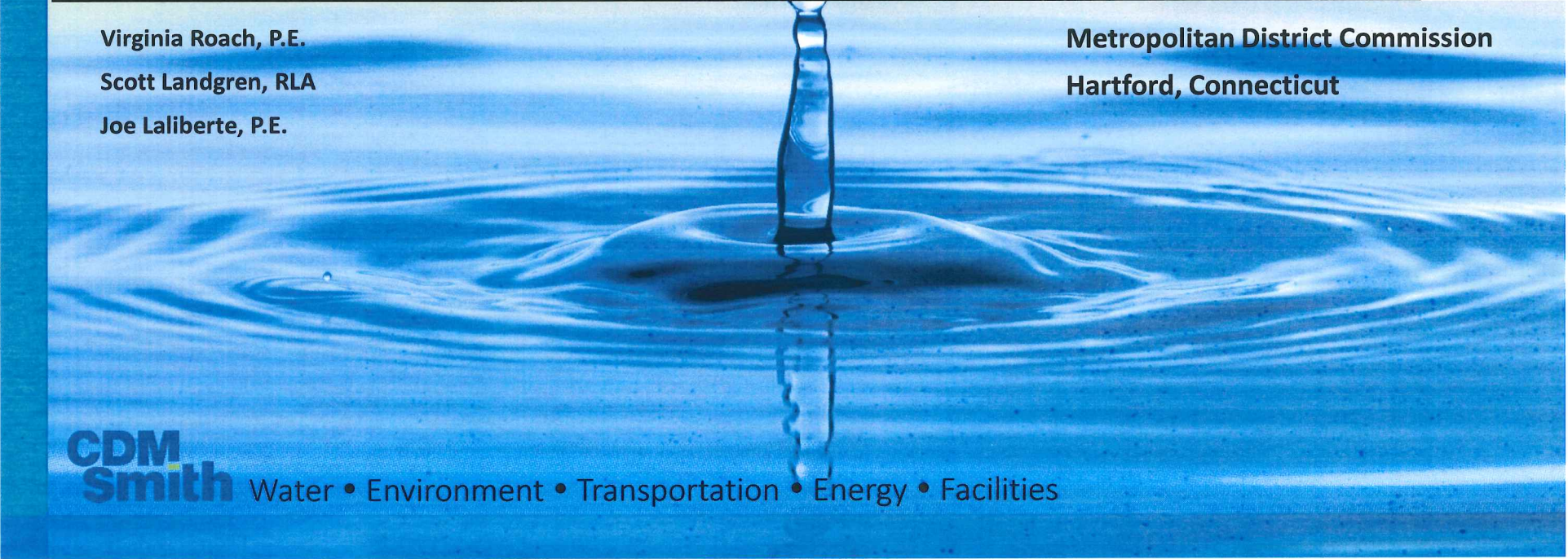
August 18, 2016

Green Infrastructure for CSO Reduction



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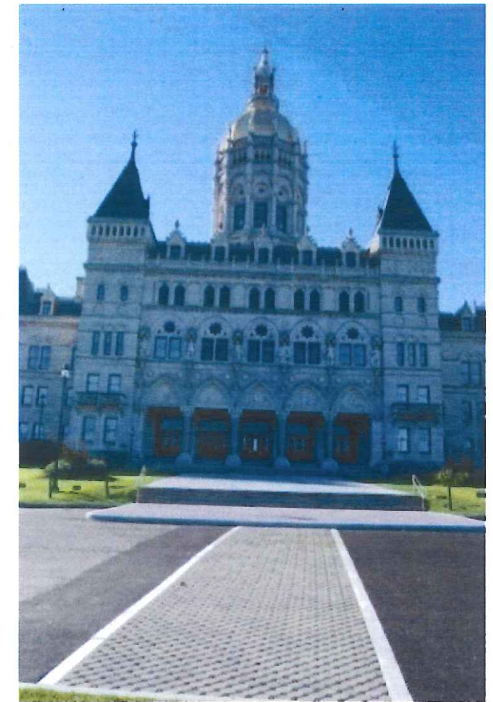
Metropolitan District Commission
Hartford, Connecticut



Water • Environment • Transportation • Energy • Facilities

Overview

- Green infrastructure
 - Purpose and benefits
 - Green vs. gray
 - Costs
 - Maintenance
 - Where has it worked well?
 - Where have there been challenges?
- What are other cities/agencies doing?
 - Comparison of level of control and green infrastructure requirements
- Applicability to MDC and next LTCP update (Integrated Plan)



Purpose and Benefits of Green Infrastructure

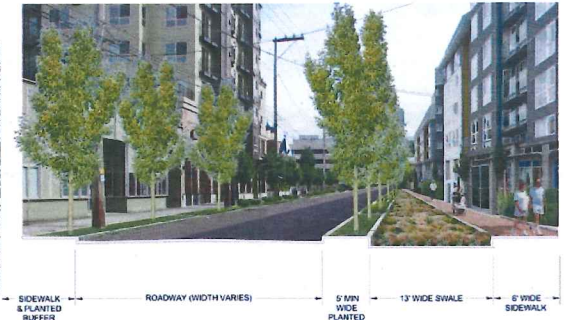
- Purpose
 - Peak rate attenuation
 - Recharge
 - Water quality improvement (MS4 Permits)
 - Volume reduction (CSOs)
- Additional Benefits
 - Erosion control
 - Flood mitigation
 - Cooler temperatures
 - Improved air quality
 - Visible green legacy



Green Infrastructure Techniques for Dense Urban Areas



Porous Pavements



Bioretention / Rain Gardens / Street Planters



Subsurface Storage / Infiltration



Green Roof



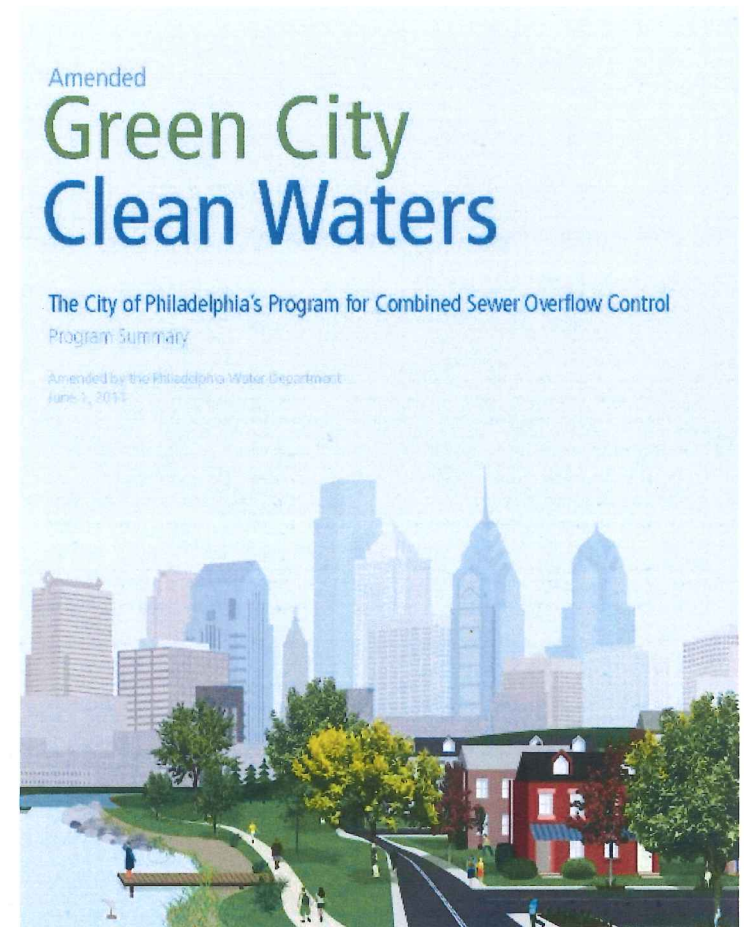
Blue Roof



Rainwater Harvesting

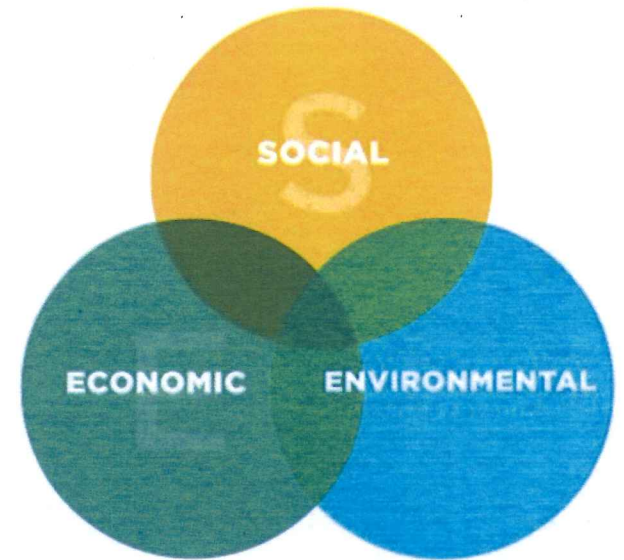
Green Infrastructure Alternatives for CSO Abatement

- National trend to implement less structural solutions which:
 - Produce similar CSO abatement results
 - Address stormwater quantity and quality issues at the same time
 - Result in more livable cities/communities in the long term



What is EPA's View ?

- At national level, have complimented major CSO plans with green emphasis
- Regionally, EPA is emphasizing flexibility in evaluating community solutions looking towards:
 - Integrated solutions
 - CSO abatement
 - Stormwater control
 - Wastewater treatment
 - Approaches that emphasize/ include green solutions
 - Consider allowing additional time to implement all



ONE WATER

ONE RESOURCE. ONE FUTURE.



Multiple Drivers of Green Infrastructure for CSO Control



- Environmental Benefits/Compliance
 - Water quality standards (CSO and Stormwater)
 - Adaptive for changing regulations
 - Improves ecosystems and habitats



- Economic Benefits
 - Holistic solutions
 - Deferment of grey infrastructure
 - Maximize public investment
 - Expand grant opportunities/alternative funding



- Social Benefits
 - Urban revitalization (green oasis)
 - Heat island/public health benefits
 - More livable and resilient cities

Triple Bottom Line

Cities Using Green Infrastructure in Their Programs

- Milwaukee
- Chicago
- Omaha
- Philadelphia
- Onondaga Co./
Syracuse, NY
- New York
- Columbus, Ohio
- Cincinnati
- Boston
- Detroit
- Toronto
- Calgary
- Madison, WI
- St. Louis
- Kansas City
- Seattle
- Cleveland

Green vs. Gray

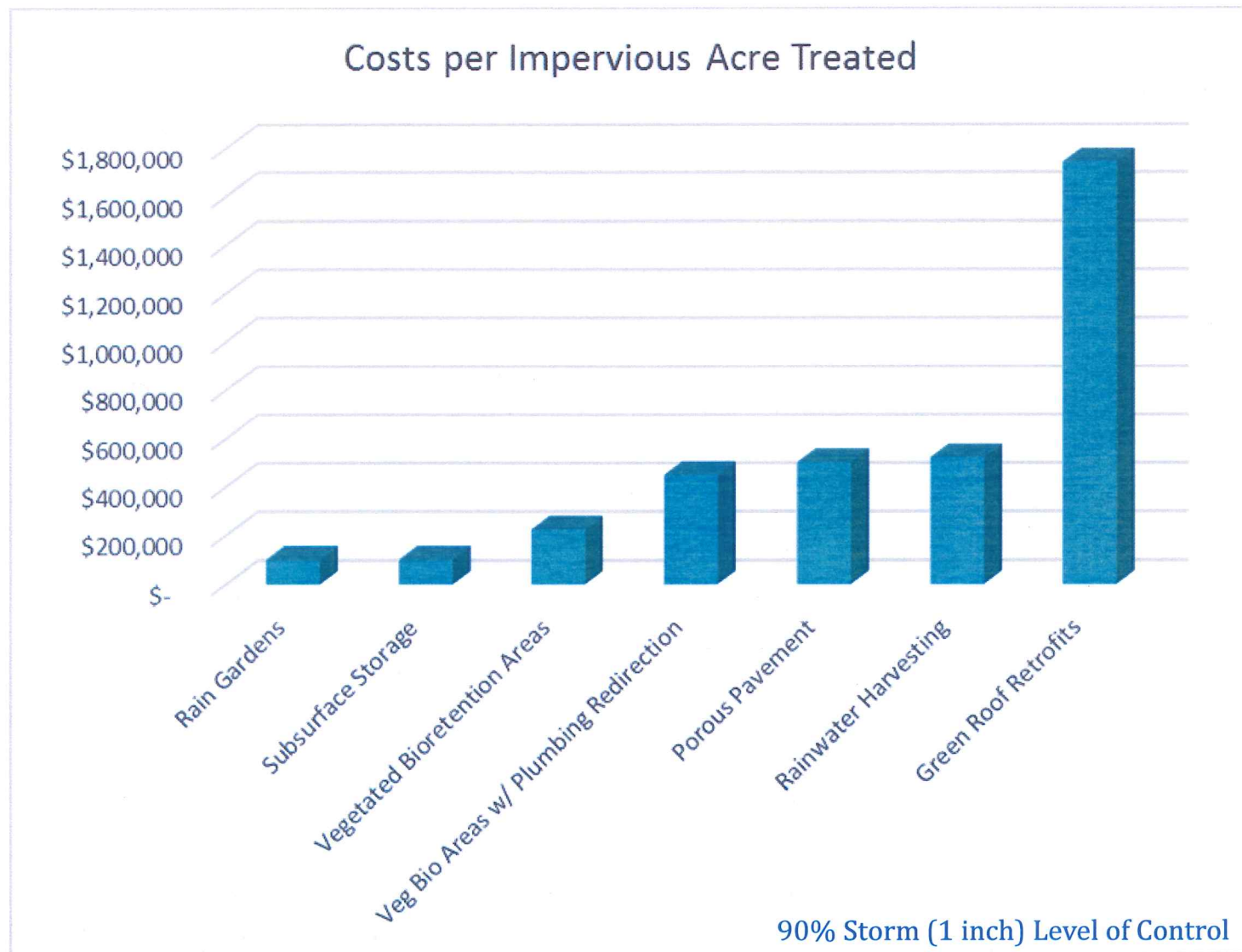
Green Infrastructure (GI)

- Weakest Day 1
- Dynamic system
- Adaptive design
- Maintenance Activities
 - Make it stronger
 - Improve the look
 - Keep it alive
 - Seasonal

Gray Infrastructure

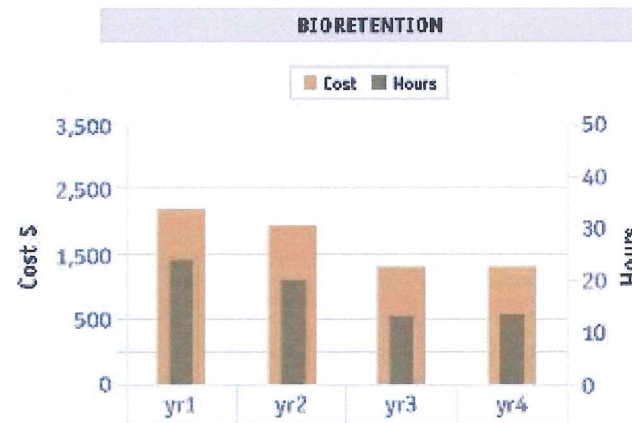
- Strongest Day 1
- Static system
- Design standards
- Maintenance Activities
 - Maintain structural integrity
 - Public does not see it
 - Clean to design capacity
 - When needed/time allows

Prioritize Most Cost-Effective Practices

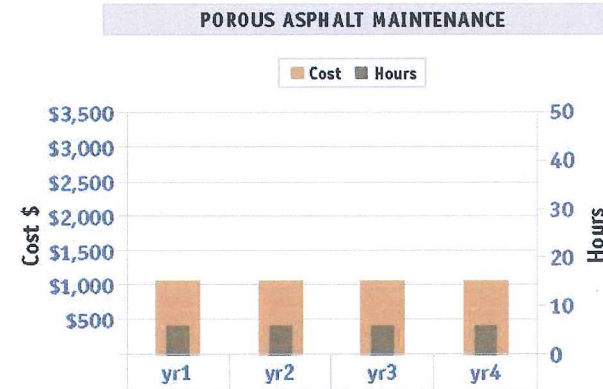


Maintenance Costs Per Acre Per Year

UNH Stormwater Center 2012 Biennial Report



Highest maintenance during first two years
Seasonal mowing, raking and pruning



Inspect at least once per year
Vacuum sweep two to four times per year

Challenges and Site Constraints

- Validity of soils data
- Bedrock
- Groundwater impacts
 - Depth (3-ft separation in CT)
 - Flow paths
 - Hotspot contamination
- Institutional issues
 - Who owns/maintains the treatment units?
 - Who pays?

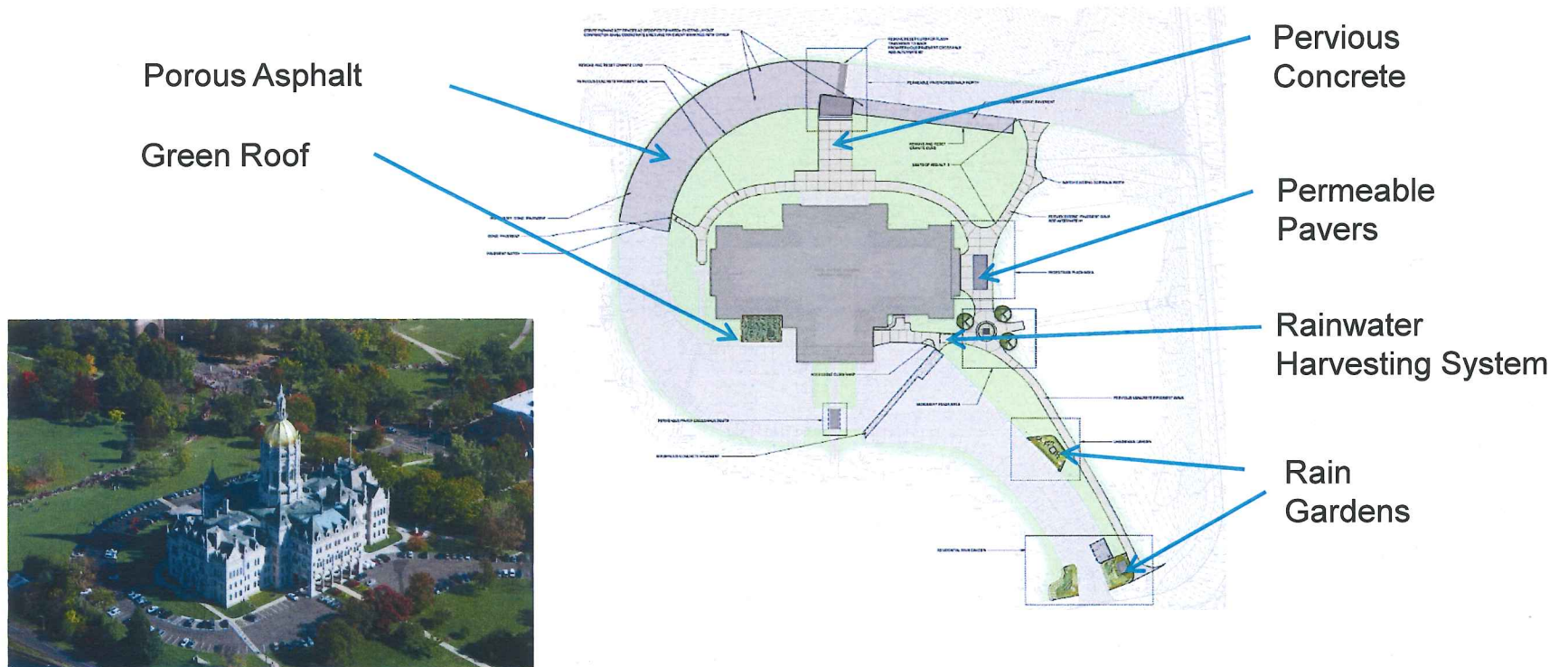


Cold Climate Green Infrastructure Challenges

- Snow removal activities
 - Plowing
 - De-icing chemicals
 - Snow storage
- Infiltration
 - Soils/Infiltration media
 - Saturated - freezes
 - Not Saturated – voids do not freeze
 - Porous pavements
 - Void spaces reduce freezing
 - UNH and University of Iowa State Studies
 - No freeze/thaw issues
 - Less de-icing and snow removal



Hartford Green Capitols Project Overview

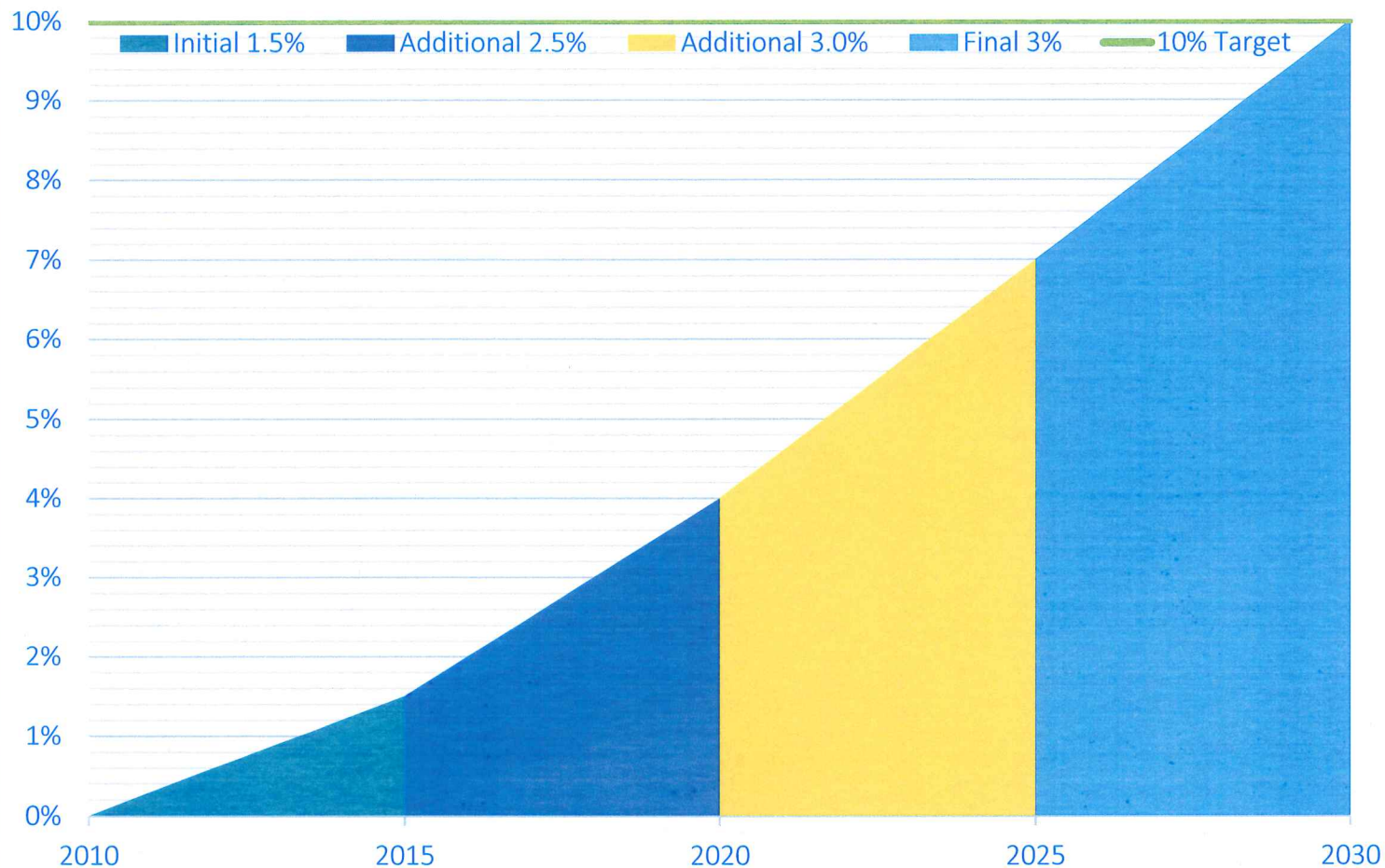


Hartford Green Capitols

Measuring Performance – Oct. 2015



New York City Green Infrastructure Application Rates and Milestone Schedule



Manage 1" of stormwater runoff from 10% of impervious surfaces in combined sewer areas by 2030

NYC Adaptive Management Plan


2014 and 2015 Annual Report Successes

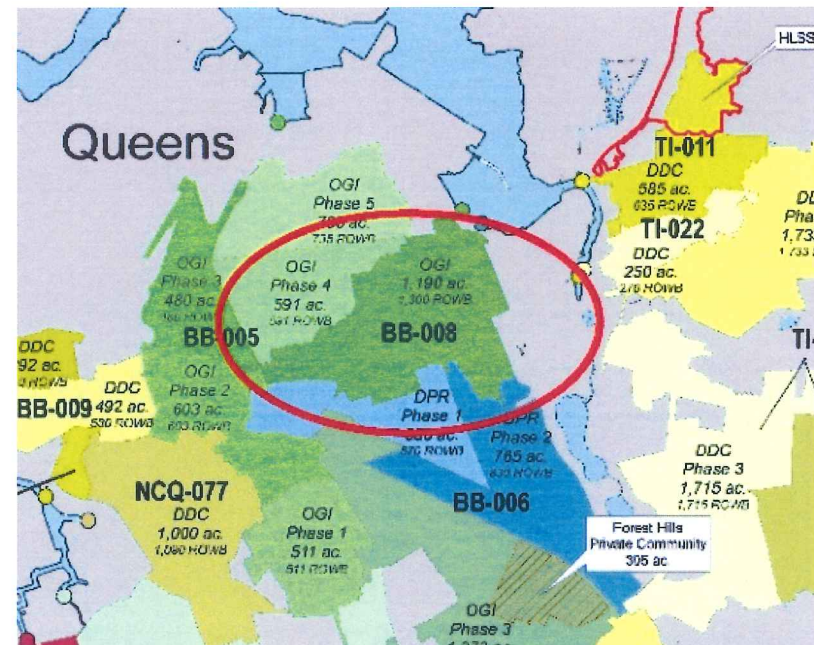
- 3 demonstration areas (70 Right-of-Way Bioswales)
 - Manage 14% of impervious areas
 - 20% reduction in runoff to combined sewer in typical storm
- By end of 2015
 - 3,830 green infrastructure practices constructed or under construction



BB-008 – Flushing Bay



 = does not meet water quality standards (pathogens/DO)



Right-of-Way Bioswales (ROWBs)



Site Selection Process

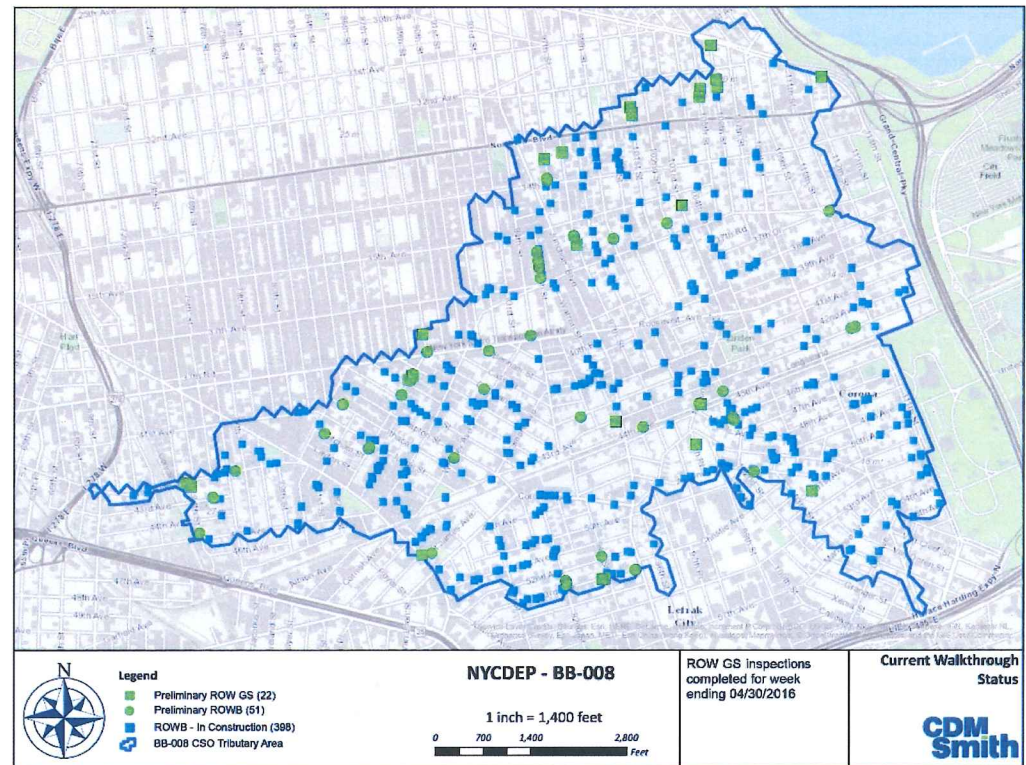
Borings and Permeability Tests



- BB-008
 - 646 geotechnical investigations representing 895 sites
 - 70% success rate
 - Permeable soils
 - Low groundwater

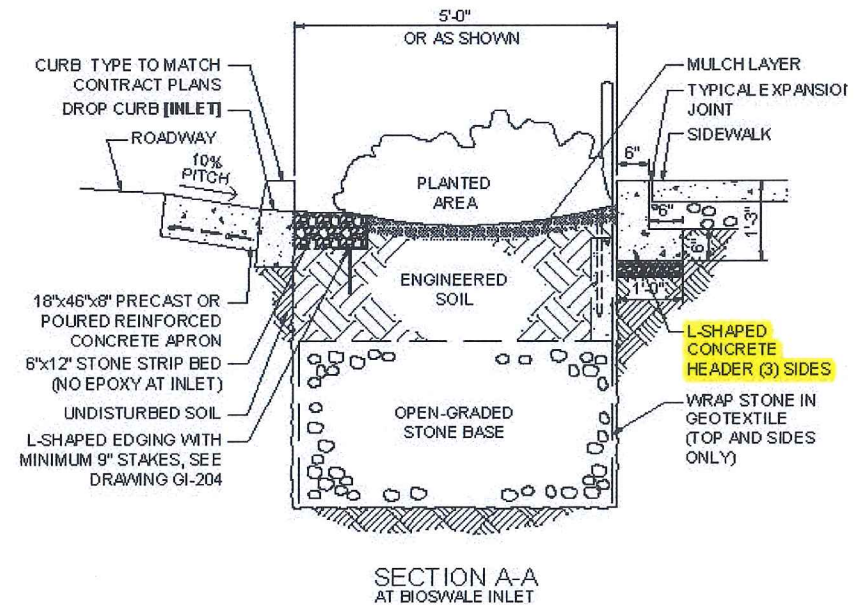
BB-008 ROWBs and ROW Greenstrips

- 4 ROWB construction contracts
 - 398 ROWBs
 - \$11,700 per ROWB
 - Manage a total of 31 acres of impervious area
 - \$150,000 per impervious acre treated
- 73 Preliminary ROW Greenstrips and ROWBs



ROWB Construction Lessons Learned

- Sidewalk flag replacement around ROWBs
 - L-shaped header design
- Contractor awareness of agency siting criteria
 - Surveyor requirement during construction
- Coordination with Department of Buildings to minimize private development conflicts (scaffolding, fences, equipment)



ROWB Maintenance

- Current NYC DEP practices
 - Inspect and remove trash every two weeks during construction
 - Inspect and remove trash every week after construction
- Evaluating maintenance practices under ongoing R&D Program
- GIS-Based Project Tracking and Asset Management System



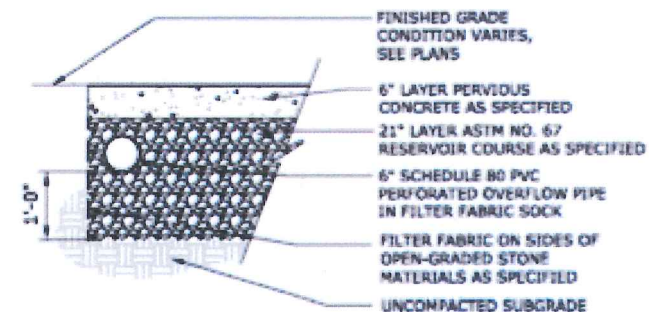
Green Infrastructure Challenges Edenwald Houses in the Bronx

- Hutchinson River CSO tributary area (HP-024)
- Largest NYCHA development in the Bronx
- 41 buildings
 - 3-story and 14-story
 - Community Center
- 5,450 residents



Edenwald Houses Geotechnical Investigations: Low Permeability Rates

- 0.00014 to 0.13 in/hr at Edenwald Houses
 - 0.2 in/hr min for groundwater recharge (NJ)
 - 0.17 in/hr min for stormwater infiltration (MA)
- At 0.13 in/hr – 3 days to infiltrate 10 inches of water
- High percentage of fines in soils (>20%)

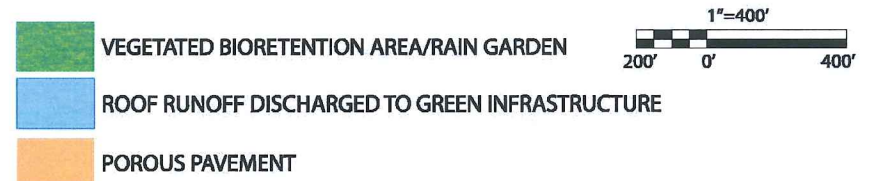


CAST-IN-PLACE PERVIOUS
CONCRETE PAVEMENT

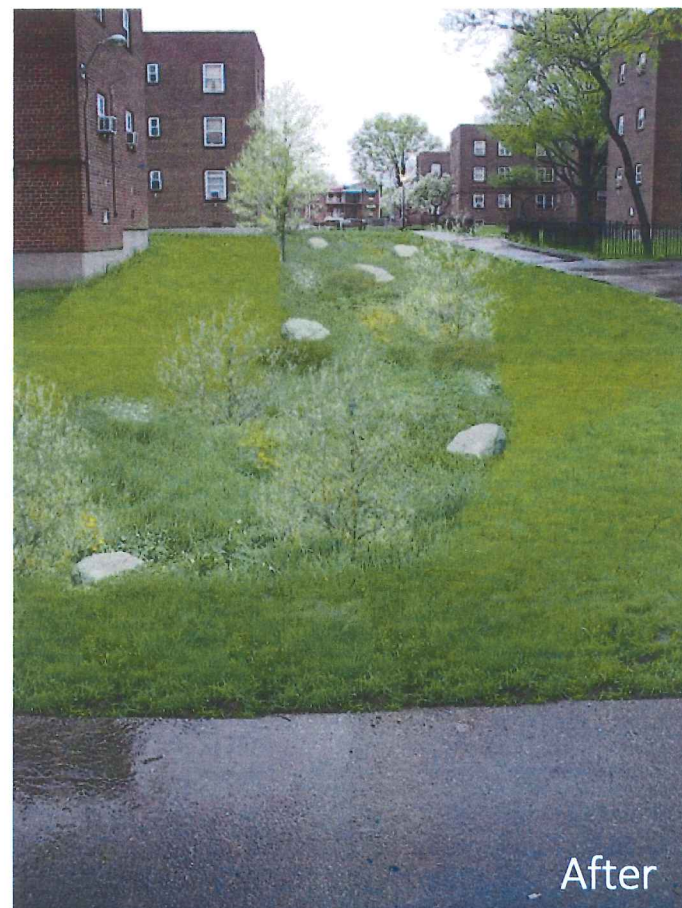
DETAIL	6
NTS	C-37

Edenwald Houses: Final Design of Green Infrastructure Practices

- Vegetated bioretention areas
- Rain gardens
- Rooftop runoff redirection to green infrastructure
- Porous pavements



Edenwald Houses Vegetated Bioretention Areas



Precast Pervious Concrete Panels



Edenwald Houses: Permeable Pavers and Rain Gardens at Entrance Areas

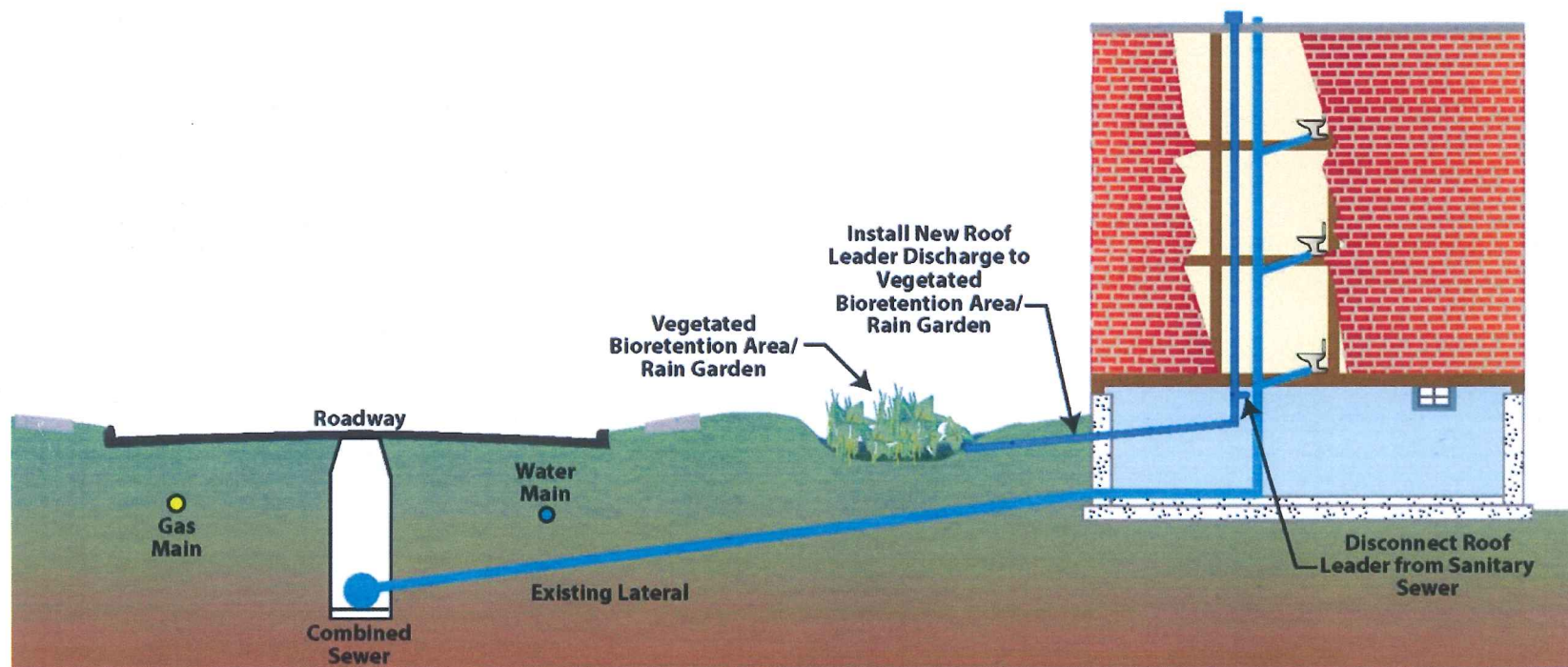


Before



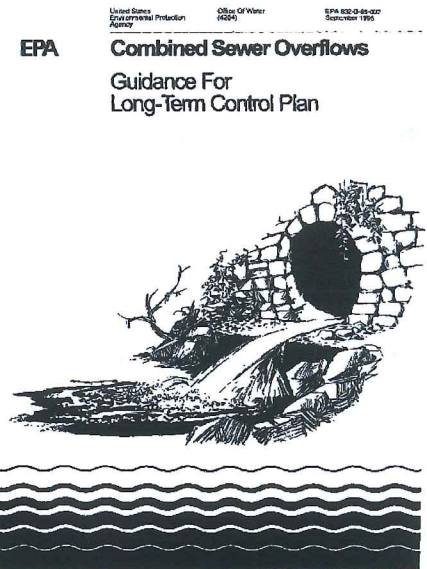
After

Edenwald Houses: Rooftop Runoff Redirection to Green Infrastructure



1994 CSO Control Policy

- A permittee may use one of two approaches:
 - 1) Demonstrate that its plan is adequate to meet the water quality-based requirements of the CWA (*“demonstration approach”*), or
 - 2) Implement a minimum level of treatment (e.g., primary clarification of at least 85 percent of the collected combined sewage flows) that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise (*“presumption approach”*).



What are Other Cities/Agencies Doing?

<https://www.epa.gov/green-infrastructure/enforcement>

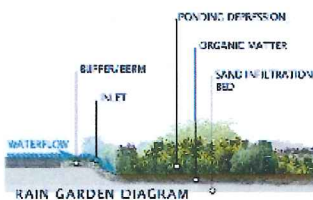
City of Philadelphia Green Streets Design Manual



Cleveland, Ohio

NEWARK GREENSTREETS INITIATIVE

CONCEPT DESIGN North Star Academy Elementary School



Massachusetts Water Resources Authority



Combined Sewer Overflow Control Plan



Annual Progress Report 2015

March 2016

CSO Communities With Green Infrastructure Consent Decrees

CSO Community	CSO Level of Control	Consent Decree Year	Green Infrastructure Goal	Green Infrastructure Capital Budget	Gray Infrastructure Capital Budget	Ratio Green to Gray Budgets
Philadelphia, PA	Approx 3-month (85% capture)	2011	Use of GI throughout the City	\$1.67 billion (additional \$420 million flexible, green or gray)	\$345 million (upgrades to WWTP capacity)	5:1
New York City, NY		2005 (2012 CSO Consent Order Modification)	Using GI to manage the first inch of runoff from at least 10 percent of impervious surfaces in combined sewer areas	\$1.5 billion	\$3 billion (\$5.7 billion including past improvements)	1:2
Cincinnati, OH	85% capture required of 14 BG annual CSOs and eliminate SSOs	2004 (amended 2009)	Construction of channel and green corridor to convey stormwater runoff to Mill Creek in Fairmont neighborhood	\$192 million	\$3.3 billion	1:17
Kansas City, MO	<1-yr (88% capture)	2010	Use GI in lieu of and in addition to structural controls; develop a plan for implementing GI projects across at least a 744-acre basin served by the POTW	\$53.5 million	\$2.42 billion	1:45

CSO Communities With Green Infrastructure Consent Decrees

CSO Community	CSO Level of Control	Consent Decree Year	Green Infrastructure Goal	Green Infrastructure Capital Budget	Gray Infrastructure Capital Budget	Ratio Green to Gray Budgets
St. Louis, MO	4 overflows/yr in some areas, elimination in others, meaningful reduction in CSOs to Mississippi River	2011	Implement GI in areas that drain to Mississippi River, particularly in areas with environmental justice concerns	\$100 million	\$4.7 billion	1:47
Chicago, IL	Approx 3-month (84% capture)	2014	Prioritize GI projects to (1) reduce flooding and basement backups, (2) can be accommodated as permanent stormwater control measures, (3) can undertake projects that will convert vacant parcels into "stormwater parks" which would store and infiltrate rainfall and be an amenity to local residents, (3) can improve socio-economic conditions	\$25 to \$50 million	\$3.4 billion	1:68
Cleveland , OH	Approx 3-month (reduce annual overflow to 0.5 BG); original plan sought 2-3 overflows/yr	2010	Use GI to capture 44 MG of annual CSO discharge	\$42 million	\$3 billion	1:71

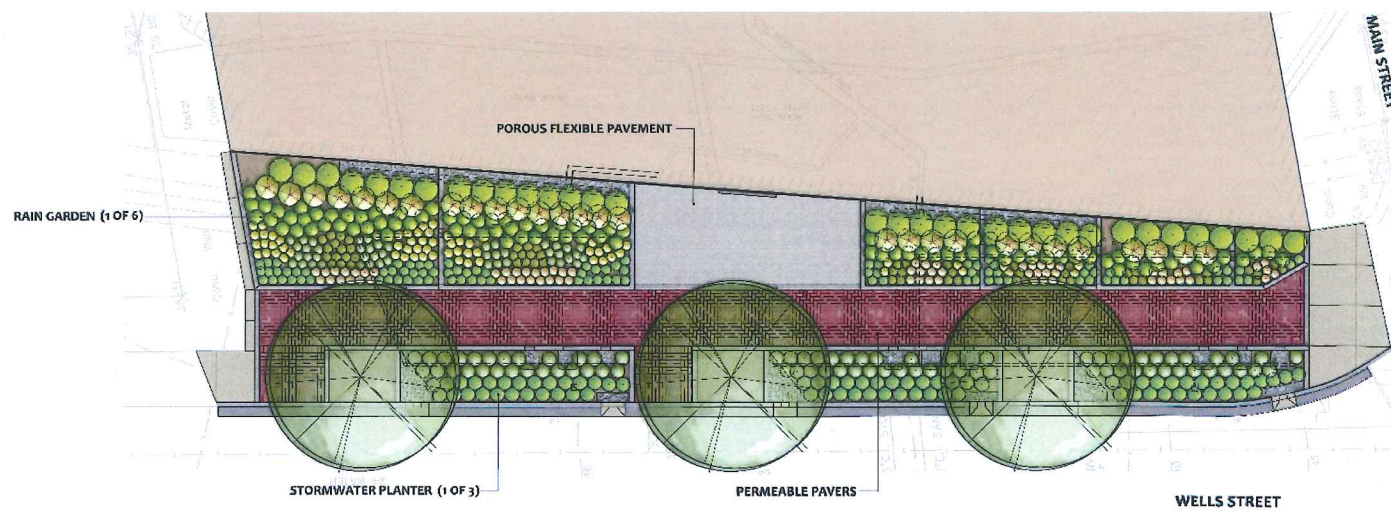
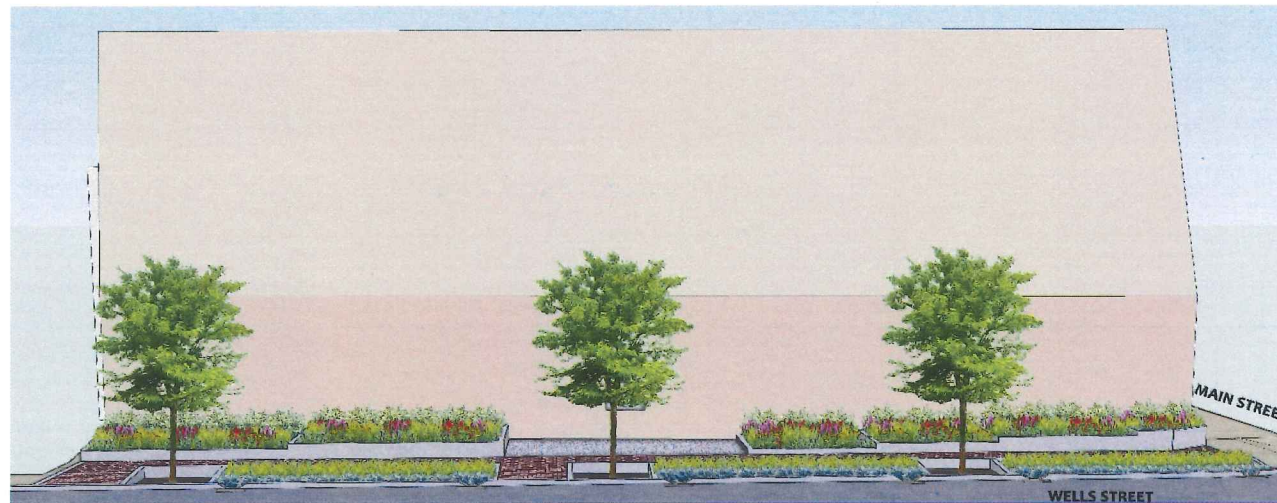
MDC's Current LTCP Status

- Long-term plan is being updated
- Focused on addressing District's aging infrastructure needs and reducing CSO overflows
- Current primary future CSO alternative is tunnel storage
- Developing Integrated Plan
 - Intent to include regulatory burden imposed by compliance with: wastewater treatment, facilities O&M, collection system CMOM, SSOs, CSOs, asset management, and stormwater compliance to develop a comprehensive program to manage those costs

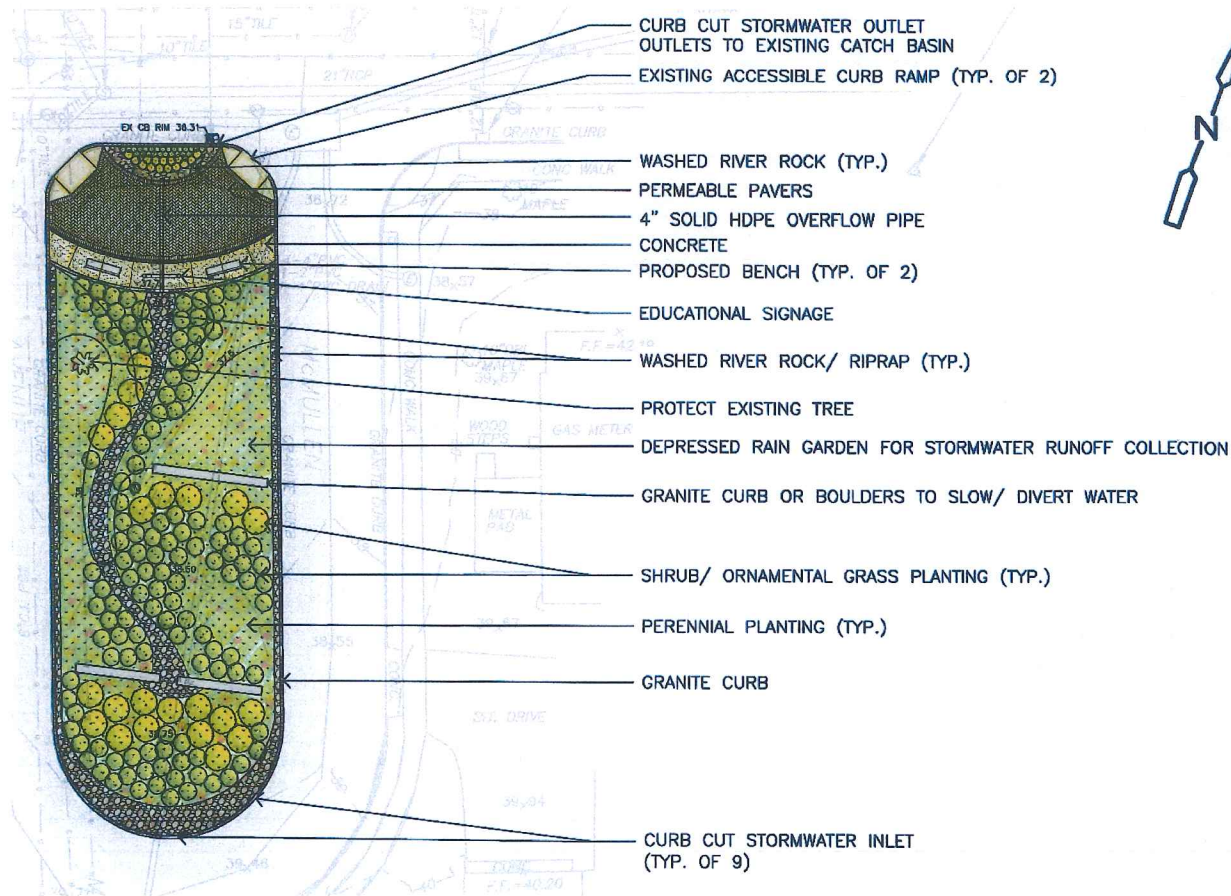
Green Infrastructure Applicability to MDC and next LTCP update (Integrated Plan)

- MDC Consent Order requires 1-year level of control
 - Green infrastructure alone not feasible to meet that requirement
- City of Hartford unwilling to date to own and maintain green infrastructure
- Environmental groups will be looking for it in next update
- Available SRF funding
- Could lengthen schedule for Consent Order compliance
- Green is typical ingredient in many Integrated Plans to include stormwater permit (MS4) compliance
- LTCP Update will evaluate applicability and cost effectiveness for inclusion of green infrastructure in candidate sites

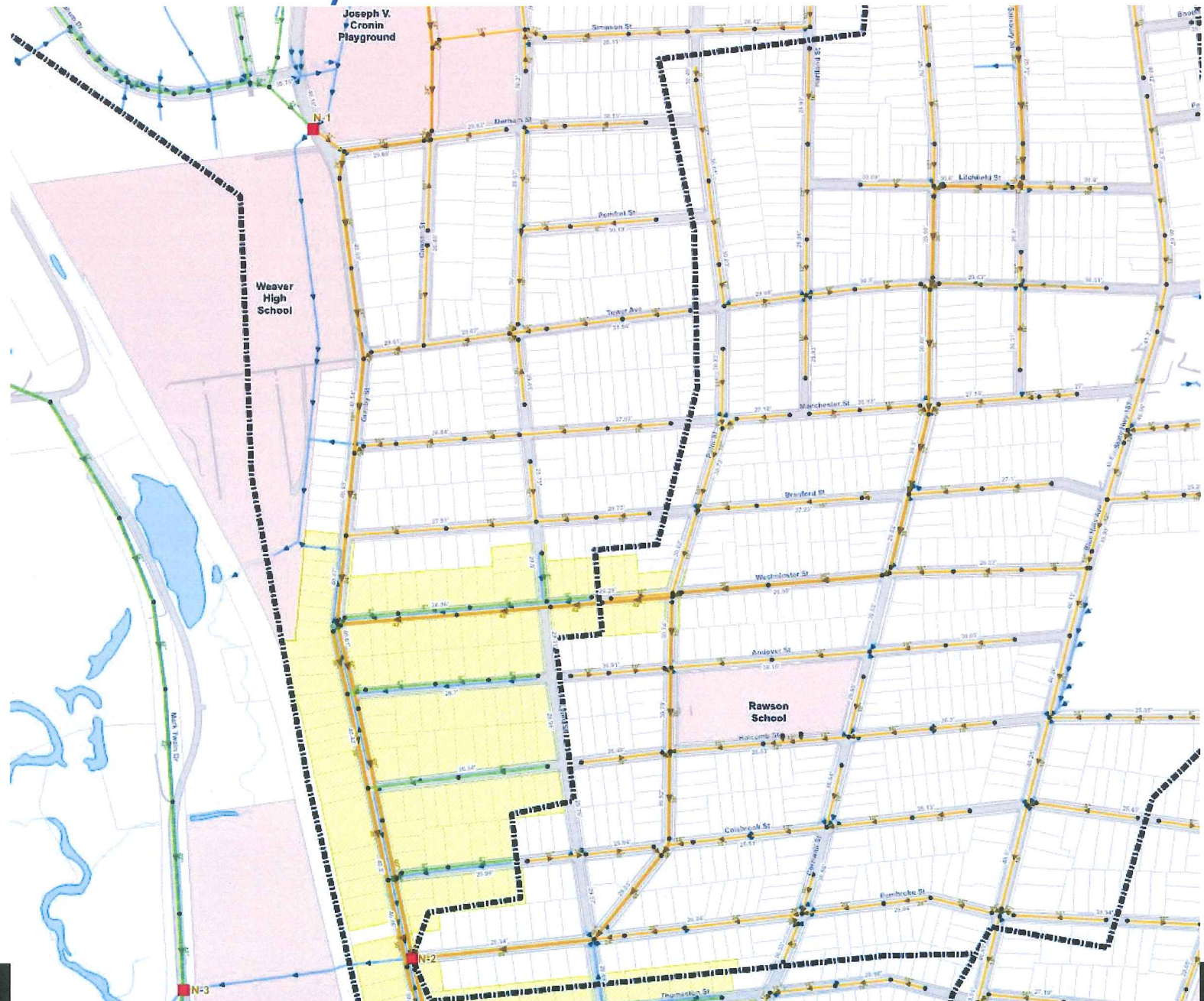
Potential Green Infrastructure Opportunities: 555 Main Street Demonstration



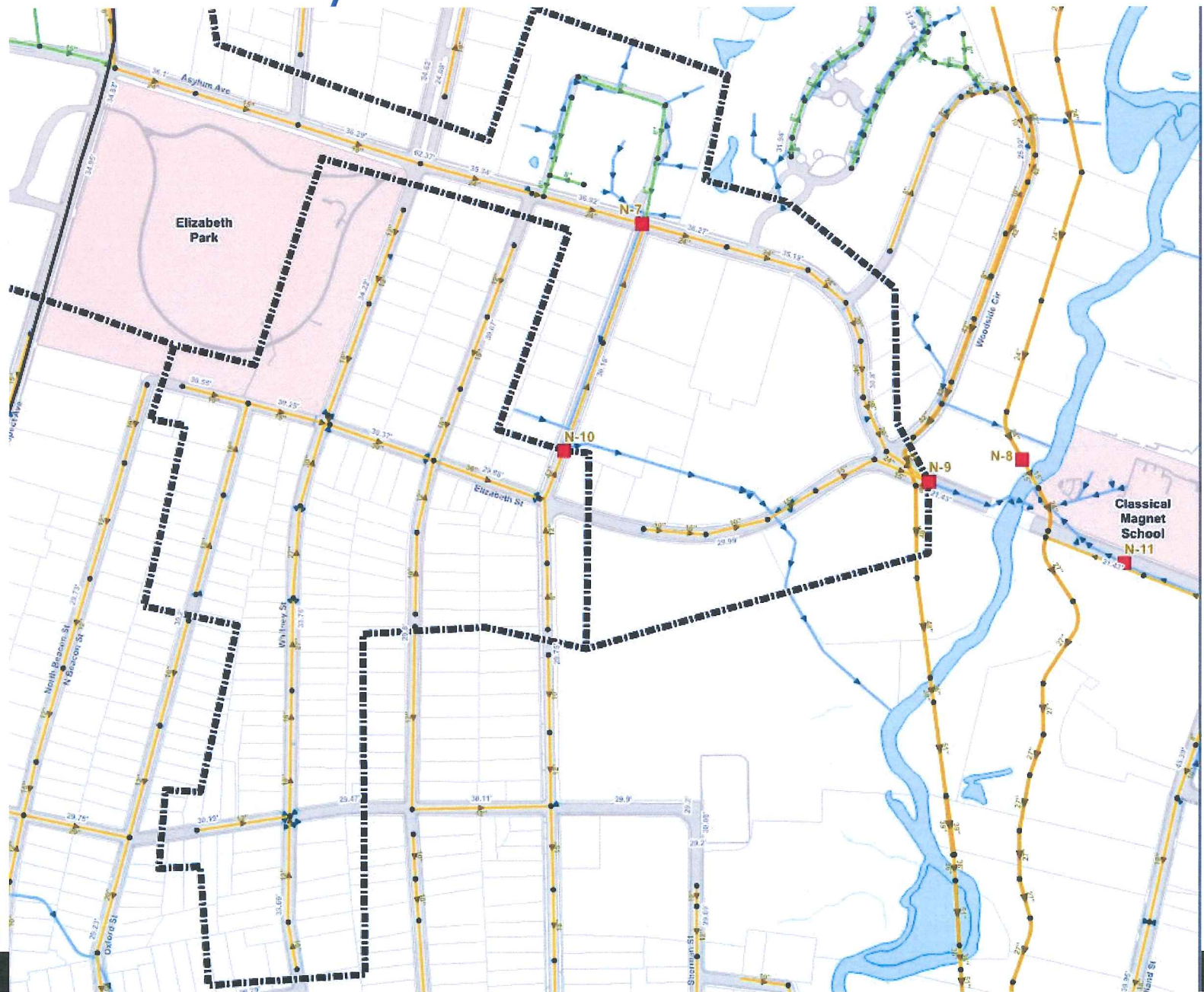
Potential Green Infrastructure Opportunities: Victoria/McMullen Intersection



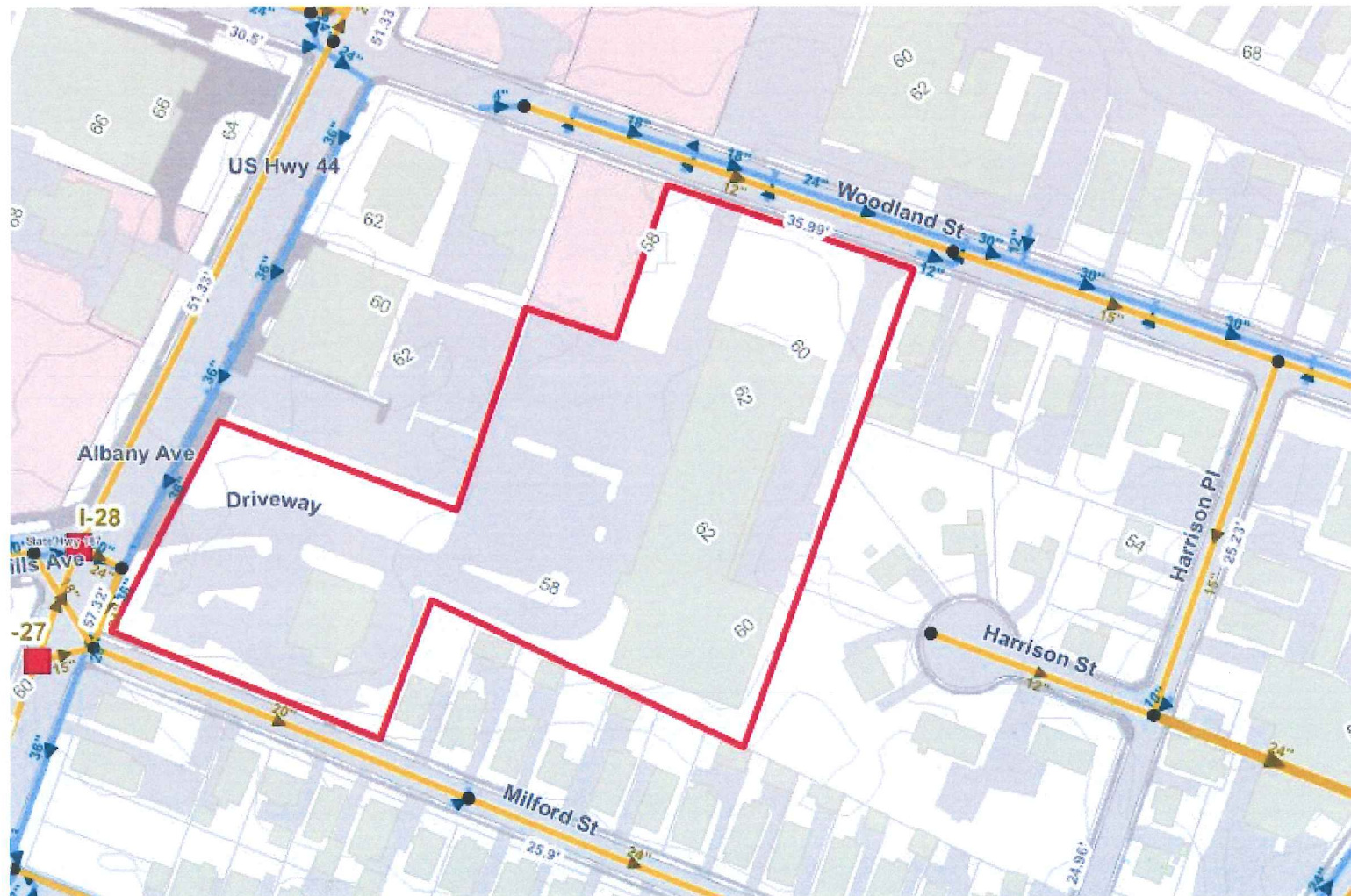
Upstream of N2/N4 CSO Outfalls



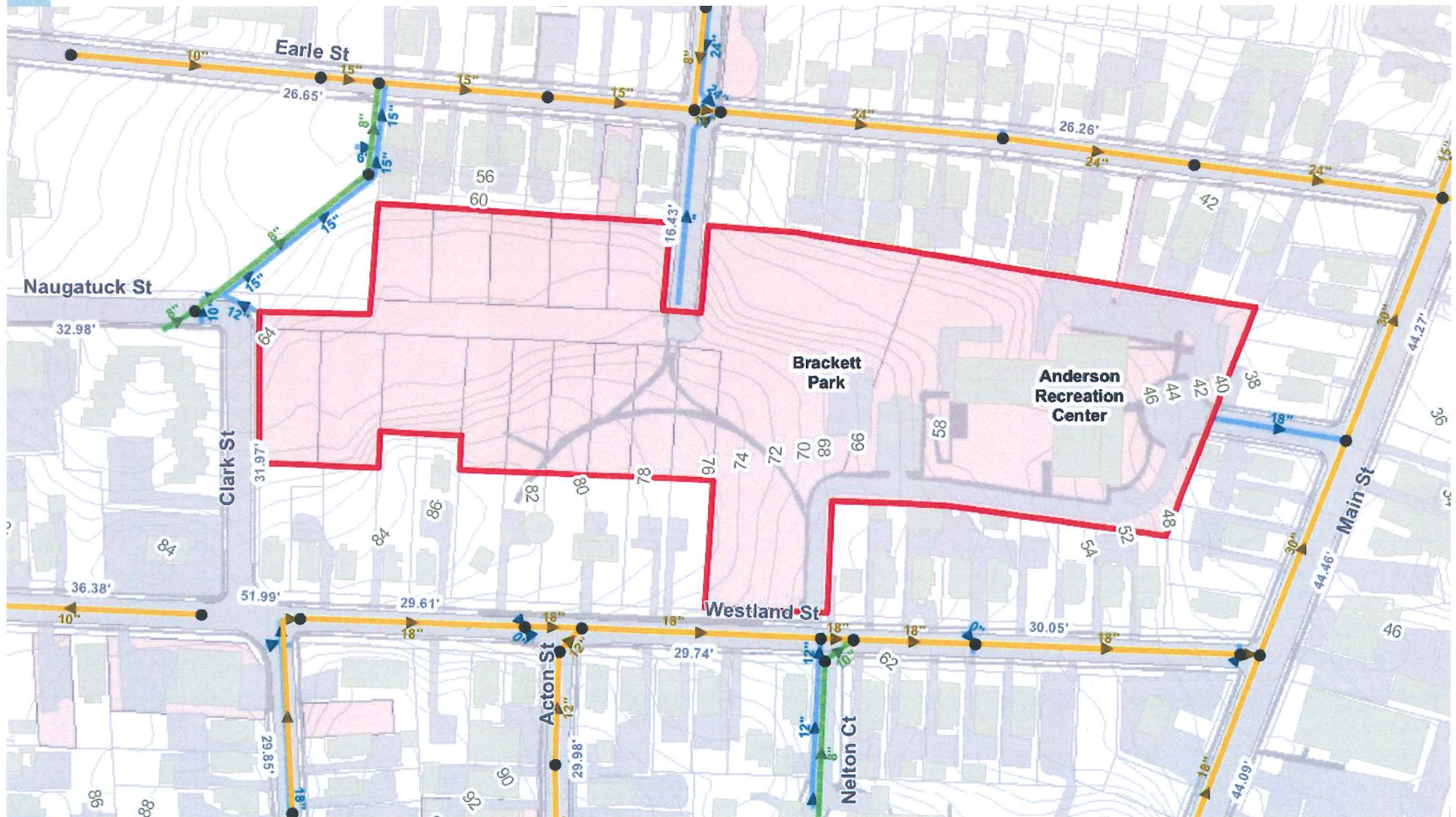
Upstream of N9/N10 CSO Outfalls



Potential Green Infrastructure Opportunities Bravo Plaza



Brackett Knoll Housing Development



**CDM
Smith**

Questions?

ONE WATER

ONE RESOURCE. ONE FUTURE.

